

DUSEL Working Group 11

Microbiology and Molecular Biology

Co-coordinators

Tommy Phelps, ORNL

Tom Kieft, New Mexico Tech

(pinch hitting for Jim Fredrickson and
Jim Tiedje)

1. Importance. What are the unique challenges and opportunities of the subsurface for biologists?

- Remote
- Opaque
- Heterogeneous
- Low nutrient flux
- Low biomass

2. What's missing?

Challenges for molecular biologists and biophysicists

- Noninvasive/nondestructive detection and quantification of microbial distribution
 - Geophysics, increased resolution of techniques at LBNL, especially if microbes are stimulated
 - GFP- or other reporter-gene based techniques
- Community genomic sequencing
 - Currently available for higher biomass environments – develop for low biomass, even single-cell sequencing
- Cell-cell metabolite exchange (important for all microbial environments, but subsurface may pose unique challenges)

2. What's missing?

Challenges for molecular biologists and biophysicists

- Analysis of the physiological state of individual cells
 - single cell “death-o-meter” _
- In situ analysis of gene expression
 - e.g., bead-based, push-pull in situ hybridization? Inject beads into a fracture and then recover.
- In situ analysis of metabolic activities – i.e., get closer to reality than just gene expression
- Extend analyses from prokaryotes to include eukaryotes and viruses

2. What's missing: Evolutionary questions

- Is the deep subsurface useful as an end member for determining rates of evolution?
 - Slow rates of cellular division, long-term sequestration of cells
- Do the extreme conditions of the subsurface select for unique genomic patterns and strategies?
 - Reduced genomic size? Fewer (or more) extrachromosomal elements (plasmids, phages), other?

2. What's missing: Evolutionary questions

- Have the extreme environments of the deep subsurface selected for unique mechanisms for macromolecular stability or repair?
- Have the extreme environments of the deep subsurface selected for particular life history strategies?
 - r vs. k selection, oligotrophs vs. copiotrophs, generalists vs. specialists?

3. Technical requirements

- Same as for Geobiology
- Direct organizational links to major facilities
 - Environmental Molecular Science Laboratory (EMSL) at PNNL
 - Joint Genome Institute (JGI)
 - others

5. Education and Public Outreach

- Range of visitor activities
 - Hands-on in situ
 - Underground lab
 - Off site individual university labs/national labs
- Visitor center at the surface to highlight sexiest aspects of deep subsurface science
- Box modules, community kits
- Classroom-designed/implemented subsurface experiments for K-12